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(54) Title: INTEGRATED CIRCUIT CONTROLLED TRANSACTION MANAGEMENT SYSTEM

(57) Abstract

An integrated circuit controlled transaction management system using an interpreter which deals with the execution of an application, either on an ICC, or on a terminal or on both, is particularly able to execute an application between the ICC and the terminal connected or not to a central unit, when the interpreter in the terminal is able to access and to use at least a part of the terminal memory and at least a part of the terminal peripherals while an optional interpreter in the ICC is able to access and to use at least a part of the ICC memory and at least a part of the ICC peripherals.

INTEGRATED CIRCUIT CONTROLLED TRANSACTION MANAGEMENT
5   SYSTEM

        The present invention relates to an integrated
10   circuit controlled transaction management system
     intended to execute a transaction between an integrated
     circuit card (ICC) and a terminal connected or not to
     a central unit, a transaction consisting of at least one
     execution of the following sequence :
15

     1.   creating a communication link between the ICC and
           the terminal ;
     2.   performing a compatibility check to ensure that
           the ICC and the terminal are mechanically and
20   electrically compatible ;
     3.   selection of an application supported both by the
           ICC and the terminal, that means the selection of
           a computer program and the associated data set
           that defines the transaction in terms of the
25   specific ICC and terminal combination present ;
     4.   execution of said application on the ICC and
           terminal system, and
     5.   termination of the transaction, which optionally
           includes breaking of the communication link between
30   the ICC and the terminal.

        Document WO 92/13322 describes a secured
     method for loading a plurality of applications in a
     microprocessor memory ICC, containing means for creating
35   a communication link in an ICC and terminal system.

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There are several types of transactions
between an ICC and a terminal :
the terminal may control access to places where only
ICC holders may have access to ; in so-called financial
5   transactions the ICC can be loaded with tokens repre-
senting consumption goods obtainable at a terminal
site (e.g. frequent flyer miles, telecommunication
units, etc...) , or the ICC may act as a depository of
bank account information which allows more general
10   financial transactions ; or the ICC may be used as data
storage, e.g. as an identity ICC or medical record
storage.
          Known features of said ICC and terminal system
   are :
15   1.   The terminal hardware (i.e. the processor and the
          peripherals, which at least include the ICC
          communication device) is accessible via the
          terminal operating system. Terminal operating
          systems are vendor specific.
20   2.   Each terminal that participates in certain types
          of standardised transaction types (e.g. interna-
          tional financial transactions) supports, for
          those transactions, a common standard allowing the
          ICCs to perform applications in a standard way
25   with terminals from any vendor. By way of example,
          international financial transactions are currently
          based on the inter industry standards as defined
          in ISO 7810/7811/7812/7813/7816.
     3.   Each provider of standardised transactions on a
30   terminal has to provide an application, i.e.
          a program and the associated data set, or an
          application specification, defined in terms of a
          common standard.
     4.   Some parties provide applications or application
35   specifications that are only partly build on a

common standard. For special requirements which are
outside the scope of the common standard, said
parties need to rely on the terminal operating
system.

5.   Other parties provide applications or application
specifications, which are proprietary to them or
which are not based on any common standard. In this
case they solely rely on the terminal operating
system to perform the transaction.

6.   Each application program needs to be compiled and
linked separately for each terminal type. This
means that specific software has to be resident in
the terminal for each application .

7.   Applications define large sets of terminal
parameters governing the rules of their acceptance.
These parameters may need to be shared with other
applications.

8.   Application software must be physically installed
in each terminal.

9.   Different versions of application software
defining the same transaction may be required on
the terminal during more or less extended
conversion periods.

The features associated with said known ICC
and terminal system loaded with multiple applications,
impose heavy constraints on the terminal hardware, which
must be able to store and to manage all possible
application software and the assorted data sets.
Moreover, a considerable logistic effort is
indispensable to manage the distribution and the
maintenance of all the software in all the terminals.
Those features have the following drawbacks :

*   Changing terminal software specifications or parts

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thereof, changing application software specifica-
tions or parts thereof or changing the implementa-
tions of a specification or parts thereof or
creating new applications requires to develop new
5   software for each target terminal type and to load
this new software in each target terminal.
Moreover, certification against all ICC types in
circulation at that moment and against those
scheduled for future release is required ;

10   *   Restricted flexibility because even minor changes
to a common standard have to be agreed between all
parties that use it ;

*   Every application requires storage capacity on the
terminal, which is limited ;

15   *   Common standards are not complete enough to
support all proprietary needs ;

*   The applications need to be implemented carefully
so that neither their programs, nor their
parameters interfere with each other ;

20   *   This approach reduces the ICC to a mere memory
device, as it is not possible to give the ICC the
control over each type of terminal due to the
plethora of different operating systems in use.

25   The above mentioned drawbacks result in a lack
of flexibility of said ICC and terminal system. Hence
the time to market new, upgraded or improved applica-
tions is extremely long, in the order of several years
as all ICCs and all terminals are affected.

30

The present invention aims to ease the
management of all possible applications with all
possible ICCs on all possible terminals. This purpose
is achieved by means of an ICC transaction management
35   system of the type described in the preamble of the

enclosed claim 1 by using an interpreter which deals
with the execution of an application either on the ICC,
or on the terminal, or on both whereby the interpreter
in the terminal is able to access and to use at least
5   a part of the terminal memory and a part of the terminal
peripherals, e.g. keyboard, display, printer, modem,
while an optional interpreter in the ICC is able to
access and to use at least a part of the ICC memory and
at least a part of ICC peripherals , e.g. keyboard,
10   display.

          Indeed, an interpreter performs the
interpretation between a program written in a compact
high level and universal language and the language
15   specific to operate the terminal or the ICC. For all
practical purposes an interpreter consists of a program
which reads an input stream (the interpreter on the ICC
reads the input stream coming from the terminal and the
interpreter on the terminal reads the input stream
20   coming from the ICC) and of one or more dictionaries,
whereby a dictionary is a collection of words, each
referring to executable statements. The interpreter
language is independent of the ICC and terminal system,
and may e.g. be FORTH (see ANSI standard : X3J14
25   Secretary, c/o FORTH Inc. 111 Sepulveda Blvd. Suite 300,
Manhattan Beach, CA 90266).

          A first advantage of using an interpreter in
an ICC controlled transaction management system
30   according to the invention, is the possibility to store
new applications or parts thereof or upgrades or
improvements to existing applications or parts thereof
on the ICC coded in an interpreted language. This allows
to reduce the time to market new applications or to up-
35   grade or improve existing applications or parts thereof.

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Time or effort required to market new, upgraded or improved applications is reduced to the time or effort required to load them in terms of the interpreter language in the ICC, which may require
5   loading new, improved or upgraded dictionaries on the ICC. In this way the ICC has control over the application. No time or effort is required to update terminals. Even when changes to terminal dictionaries must be made, it is sufficient to load the new, upgraded
10   or improved definitions in the ICC during an introductory or reconversion period until the new upgraded or improved definitions are available on the terminal. It is possible to implement the ICC and terminal system in such a way that the new , upgraded
15   or improved definitions in the ICC are transferred to the terminal during a transaction and stored permanently in the terminal memory thereafter .

Management of terminal functionality is reduced to the installation once of the same interpreter
20   program and the same interpreter language dictionary, hereafter referred to as interpreter core dictionary, either during the manufacturing process of the terminal or   thereafter . It is possible to upgrade or improve the interpreter after installation of the terminal, e.g.
25   by means of on-line down-loading or through an ICC . Optional additional dictionaries, e.g. proprietary dictionaries or common standard dictionaries may be loaded on the terminal.

30   A second advantage of using an interpreter in an ICC controlled transaction management system according to the invention is that the support for many applications on the terminal is reduced to the availability on the terminal of the interpreter program
35   and the interpreter core dictionary and identifications

7.

of the supported applications. Additional dictionaries
are optional.

A third advantage of using an interpreter in
5   an ICC controlled transaction management system
according to the invention is the possibility for
the ICC to fully define and hence control the
application.

10   The present invention provides the possibility
to efficiently manage many applications on many
fundamentally different terminals and the
possibility to install new or improved or upgraded
applications or parts thereof in a very efficient way,
15   to have an extremely short time to market of new,
upgraded or improved transactions and to allow the ICC
to control the transaction.
           Positive implications of the above are:
     *   Changing terminal software specifications only
20   affects the interpreter implementation on that
           terminal. The only effort needed to maintain
           compatibility with existing applications is to
           ensure that the interpreter program and the
           interpreter core remain implemented correctly.
25   Hence only one software needs to be recertified,
           and only against one specification, namely the
           interpreter definition. ICCs need not to be
           recertified as the interpreter language used in the
           application retains the same specification.
30   *   The need for common standards is reduced to
           the availability of the interpreter as each
           standard function can be coded in the interpreter
           language and stored in the ICC.
     *   Introducing new, improved or upgraded applications
35   needs not to affect dictionaries that have to be

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stored on the terminal, as all applications and
related dictionaries are defined in terms of the
interpreter language and can be loaded on the ICC.
*   The application data sets are all managed by the
5   interpreter, which eases their management.
*   The ICC can take actively part in the execution of
the application program or parts thereof by also
implementing an interpreter program and core
dictionary on the ICC. If the ICC is a mere memory
10   ICC, it can still control the application by
completely storing it, i.e. the terminal acts
completely according to the ICC definitions.

Some applications may require specific
15   security services, e.g. data integrity, ICC
authentication, terminal authentication or data
confidentiality. These can be provided with state of the
art techniques as defined e.g. in ISO 10202.

20   According to a first particularity of the
invention, an application consists of one or more
functions, each function consisting of a controlling
part referred to as the header of the function and an
executable part referred to as the body of said
25   function. The header determines which bodies have to be
executed and under which conditions. Both parts of the
function are able to be independently stored in a
dictionary. Functions may be defined in terms of other
functions, i.e. functions may be nested.
30

A body which is stored in a dictionary is
accessible via its body name, and a header stored in a
dictionary is accessible via its header name. This does
not prevent in any way to program a function in the
35   interpreter language, it merely offers the possibility

to write compact and yet flexible applications by carefully mixing body names, header names and interpreter language code. Functions themselves can also be stored in dictionaries, referred to by means of their header names. This reference method allows to define each function in four ways:

1. Both the header and the body can be interpreter language code ;

2. The header can be interpreter language code while the body is activated through its body name ;

3. The header is defined through its header name, while the body is fully expanded interpreter language code ;

4. Both the header and the body are stored as references, header name and body name respectively.

The invention allows the presence of several types of dictionaries in the ICC and terminal system:

1. the interpreter core, a mandatory dictionary;

2. a number of optional dictionaries including definitions relating to :

a) certain types of standardized transactions, e.g. the dictionary containing all functions defined in ISO/IEC 7816 used in international financial transactions, referred to as the standard dictionary ;

b) proprietary transactions, requiring non standard definitions, referred to as proprietary dictionary ;

The dictionary defined on the ICC may contain new, improved or upgraded functions or parts thereof. Those dictionaries normally take precedence over terminal dictionaries. However the security of some applications may prohibit the redefinition of certain

words in certain dictionaries.

Security features can be provided through the specific protection mechanisms available in state of the art interpreter implementations.

5

      The invention allows to store an application efficiently on the ICC and allows for flexible execution on the ICC and terminal system. Indeed, the following storage scenarios are possible thanks to the invention:

10   1.   The transaction fully adheres to a standard. This means that the ICC only has to store the function name of the application, which is defined in the standard dictionary on the terminal;

    2.   If the transaction is proprietary and the

15   application is defined on the terminal it communicates with, the ICC only has to store the function name of the application, which is defined in the proprietary dictionary on the terminal;

20

    3.   If the transaction is proprietary and the application is not defined on the terminal it communicates with, the definition of the application must then be stored on the ICC, in the

25   ICC dictionary. The functions of the application can use body names and header names of both the standard and the proprietary dictionaries, but can also include interpreter language code.

30   Example 1 :

      Assuming an application with the following header (given in pseudo-code) :

if (x=1) then func_a(y)

             else if (x_2) then func_b(y)

35   else func_c(y)

whereby func_a, func_b and func_ c are defined in the terminal proprietary dictionary. Assuming func_a(y)=y+x, in that dictionary. Then the header as presented above is all that needs to be stored in the ICC to be able to execute it. In this case there is no need for an ICC dictionary. Now, assuming the interpreter implementation allows ICC dictionaries to take precedence over terminal dictionaries, and assuming the application provider wants to redefine func_a(y), into func_a(y)=y-x. In this case he can still use the same header, and he now has the choice to either update all proprietary dictionaries in all terminals, or to include the new definition in the ICC dictionary. This new definition will then be used during the execution of the application.

The invention allows that :
a)   a ICC dictionary can be used to add to, improve or upgrade terminal dictionary definitions. A mechanism to do this is e.g. provided in the FORTH language, where the words defined last can redefine earlier dictionary entries.
b)   some dictionaries, e.g. the interpreter core or the standard dictionary for some applications, may be protected against erasure and against redefinitions. Techniques to achieve such protection are state of the art; an example is presented in patent WO90/05347.

The following execution scenarios are possible thanks to the invention:
1.   The terminal executes the application program or parts thereof, whereby the ICC only acts as a data container and possibly as a storage device for the

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proprietary application program, or parts thereof.

2. Both the ICC and the terminal execute parts of the application. For security reasons it might be required that certain data do not leave the ICC, hence all manipulations involving such data must be executed by the ICC. Hence the ICC and the terminal communicate results of data manipulations instead of the data itself.

3. The ICC executes the application, whereby the terminal only needs to contain application identifications it supports. In this case the terminal may be used as a mere storage device, e.g. the terminal can provide the ICC with a dictionary that contains definitions of functions in terms of the interpreter language that are used during the execution of the application by the ICC.
   This allows the ICC to use definitions without having to store them.

The above means that the invention brings following advantages :

1. The flexibility to define, improve or upgrade applications very easily and quickly by storing them on the ICC, relying on the terminal interpreter for execution and relying on the terminal interpreter core dictionary for definitions.

2. The flexibility to store applications in a compact way on the ICC using dictionaries on the terminal.

3. The flexibility to execute the application in either the ICC, the terminal or both ICC and terminal, depending on the availability of processing power in the ICC and the terminal.

4. The flexibility to allow multiple ICCs to

participate in a transaction. The interpreter can
be implemented in a terminal with multiple ICC
readers.

In such a system it is possible to provide
applications, either stored on one or more ICCs,
a terminal or any combination of terminal and ICCs,
that perform ICC to ICC transactions. In this case
the terminal could be very simple, only providing
the communication means between the ICCs and
possibly providing some dictionaries to reduce the
storage requirements on the ICCs.
The ICCs could also provide resources to each
other.

5. The flexibility to control the transaction from
both the ICC, the terminal or both the ICC and the
terminal.
The transaction is the result of the execution of
an application and hence is fully determined by
the application program and the associated data
set. As such control of the transaction or parts
thereof is determined by the contribution from the
ICC, the terminal or both the ICC and the
terminal. When the transaction is fully determined
by a terminal resident application the card can
only contribute to the application with a data set
it contains and then undergoes the transaction .
When the transaction is fully determined by the ICC
resident application, the terminal contributes to
it with its data set and undergoes the transaction.
The terminal and the ICC can also perform the
transaction as equals, whereby both determine and
perform the transaction . It may occur that the
ICC and terminal system is connected to a central
unit from which it requests additional services,
in which case the central unit may dynamically

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contribute to the application. E.g. the ICC can
force the terminal to connect to its central unit
and request the update of data on the ICC. The
control of the application does not need to be
5   strictly on the ICC or on the terminal .

        In an initial step an application has to be
selected for execution on the ICC and terminal system.
This selection is trivial when the ICC and the terminal
10   have no application or exactly one application in
common. When multiple applications are supported both
by the terminal and by the ICC, the current practice is
to let the ICC holder or the terminal operator define
interactively which application is chosen. This is not
15   precluded by the invention which also provides an
intelligent mechanism to select the application,
depending on ICC parameters, terminal parameters and ICC
capabilities and terminal capabilities.
Indeed, after insertion of the ICC in the terminal and
20   after the ICC has satisfied all compatibility checks,
the first action the terminal undertakes is to check
whether the ICC supports an application it knows. In
order to find this out, the terminal will try to
consecutively select one of its resident applications.
25   If an application is present on the ICC, the ICC
contains the description of the application. According
to the invention, a possible body in the application
header is an application select function. This
application select function is to be executed by the
30   interpreter with arguments determined by the ICC. This
means that with an application supported by the terminal
and defined in the ICC, the selection of one of the many
applications only defined on the ICC is made possible
. Since the bodies of an application selection function
35   may be application select functions, the application

may be selected recursively.

5   Example 2 :

         The following example is considered :
     The ICC contains the following applications: Euro, Euro-
     Debit, Euro-Credit, Us-Debit, Us-Credit. The terminal
10   only knows the application Euro. When the terminal
     inspects the ICC, the result of the select application
     function will be Euro and its related data.
     The definition of application EURO can be stored either
     on the terminal or in the ICC. Assume it is stored in
15   the ICC, then it could be defined as follows (in pseudo
     code):
     start
     if (ICC amount <100)
        then if (terminal is located in Europe)
20   then select application Euro-Debit
                 else if (terminal is located in US)
                   then select application US-Debit
                   else abort transaction
        else if (terminal is located in Europe)
25   then select application Euro-Credit
                 else if (terminal is located in US)
                   then select application US-Credit
                   else abort transaction
     end transaction,
30   wherein
     *   not underlined text means the header, and
          underlined text means a body.
     In this case, the terminal only knowing EURO can select
     applications defined in the ICC.
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Any implementation of the present invention entails the following effort :

1   If the ICC is to be used as a mere memory ICC:

   a)   implementing a secure interpreter on the
        terminal, with its interpreter core
        dictionary ;

   b)   defining and implementing dictionaries for the
        application ;

   c)   implementing the application in the
        interpreter language, possibly making use of
        available dictionaries ;

   d)   implementing a mechanism to use the ICC
        dictionaries.

2.   If the ICC takes an active part in the execution
of the application:

   a)   implementing a secure interpreter and its core
        dictionary on the terminal and implementing a
        secure interpreter and its core dictionary on
        the ICC .

   b)   defining and implementing dictionaries for the
        applications ;

   c)   implementing the application in the
        interpreter language, possibly making use of
        the available dictionaries ;

   d)   implementing a mechanism on the terminal to use
        ICC dictionaries.

   e)   implementing a mechanism on the ICC and the
        terminal to manage the execution of the
        applications on the ICC and terminal system

   f)   implement a mechanism on the card to use
        terminal dictionaries.

        The invention is obviously not limited to a
transaction management system using a card . Many
changes may be made in the shape, the arrangement and

the constitution of the integrated circuit carrier ,
without departing from the scope of the invention , e.g.
a key or a badge .

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CLAIMS

1.   An integrated circuit controlled transaction
management system intended to execute between an ICC and
a terminal connected or not to a central unit, a
transaction consisting of at least one execution of the
following sequence :

1.·   creating a communication link between the ICC and
        the terminal ;

2.   performing a compatibility check to ensure that
        the ICC and the terminal are mechanically and
        electrically compatible ;

3.   selection of an application contained in the ICC
        and the terminal, that means the selection of
        computer program and the associated data set that
        defines the transaction in terms of the specific
        ICC and terminal combination present ;

4.   execution of said application on the ICC terminal
        system, and

5.   termination of the transaction, which optionally
        includes breaking of the communication link between
        the ICC and the terminal,

characterized in that it uses an interpreter which deals
with the execution of an application, either on the ICC,
or on the terminal or on both, whereby the interpreter
in the terminal is able to access and to use at least
a part of the terminal memory and at least a part of the
terminal peripherals while an optional interpreter in
the ICC is able to access and to use at least a part of
the ICC memory and at least a part of the ICC
peripherals .

2.   Transaction management system according to

claim 1, characterized in that each application consists
of a number of functions , each function consisting of
controlling part referred to as the header and an
executable part referred to as the body of said

5   function, both parts of said function possibly being
independently stored in a dictionary.

    3.   Transaction management system according to
claim 1, characterized in that functions may be nested.

10

    4.   Transaction management system according to
anyone of claims 1 to 3, characterized in that a
function in the application description is a "select
application function" which is executed by the

15 interpreter with arguments determined by the ICC, so
that the application select may be executed recursively.

    5.   Transaction management system according to
anyone of the previous claims , characterized in that

20 the interpreter in the ICC is able to access and to use
at least a part of the ICC memory and at least a part
of the associated ICC peripherals.

    6.   Transaction management system according to

25 one of the previous claims, characterized in that the
interpreter in the terminal is able to access and to use
at least a part of the terminal memory and at least a
part of the terminal peripherals.

30   7.   Transaction management system according to one
of the previous claims, characterized in that the ICC
is a mere memory ICC which undergoes the transaction
as determined by the terminal .

35   8.   Transaction management system according to one

of the claims 1 to 6, characterized in that the ICC
determines the transaction and the terminal which needs
only to recognise an application on the ICC and able to
select it, undergoes the transaction.

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9.   Transaction management system according to one
of the claims 1 to 6, characterized in that the ICC and
the terminal both determine and perform the transaction.

10   10.   Transaction management system according to
claim 8, characterized in that the terminal is a pure
interface device between a number of ICCs.

11.   Transaction management system according to one
15   of the claims 7 to 9, characterized in that each ICC
contains a differently personalised application.

12.   Transaction management system according to one
of the previous claims, characterized in that an
20   interpreter is implemented in a terminal with many ICC
readers, and provided with applications, either on the
ICC, terminal or both, that perform combination of
transactions.

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INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6   G07F7/10   G06K19/07

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6   G07F   G06K   G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	FR,A,2 667 171 (GEMPLUS CARD INTERNATIONAL) 27 March 1992 see abstract; claims; figures 1-3	1,5,8,11
Y	WO,A,94 10657 (INTELLECT AUSTRALIA) 11 May 1994	1,5,8,11
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[ ] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

2

Date of the actual completion of the international search	Date of mailing of the international search report
10 November 1995	2 7. 11. 95

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	David, J

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